FINAL

SUPPLEMENT ANALYSIS FOR TRANSPORTATION OF DOT COMPLIANT DEPLETED URANIUM HEXAFLUORIDE CYLINDERS FROM THE EAST TENNESSEE TECHNOLOGY PARK TO THE PORTSMOUTH GASEOUS DIFFUSION PLANT IN FISCAL YEARS 2003 THROUGH 2005

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TABLE OF CONTENTS

TABLES

TABLES (CONT.)

FIGURE

1 INTRODUCTION

1.1 PURPOSE AND SCOPE

The U.S. Department of Energy (DOE) maintains approximately 700,000 tonnes[1] (t) of depleted uranium hexafluoride (DUF_6) in about 58,000 cylinders stored at three DOE sites: the Paducah site near Paducah, Kentucky; the Portsmouth site near Portsmouth, Ohio; and the East Tennessee Technology Park (ETTP) site on the Oak Ridge Reservation, Oak Ridge, Tennessee. Management of this DUF_6 was the subject of the *Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DUF_6 PEIS) published by the DOE in April 1999 (DOE 1999a). The PEIS assessed the potential environmental impacts of alternative management strategies for the DUF_6 currently stored at the three DOE sites. The alternatives analyzed included no action, long-term storage as DUF_6, long-term storage as uranium oxide, use as uranium oxide, use as uranium metal, and disposal. Included in the PEIS analyses were the estimated potential environmental impacts associated with the transportation of full DUF_6 cylinders from each site by both truck and rail over a range of shipment distances.

Section 1502.9c of the *Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (NEPA), *Code of Federal Regulations* Title 40, Parts 1500-1508 (40 CFR Parts 1500-1508), requires the preparation of a Supplemental Environmental Impact Statement if (1) the agency makes substantial changes in the proposed action that are relevant to environmental concerns; or (2) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. The same section also states that the agency may prepare supplements when the agency determines that the purposes of the NEPA will be furthered by doing so. Section 1021.314c of the DOE NEPA Regulations (10 CFR Part 1021) provides that when it is unclear whether or not an EIS supplement is required, DOE will prepare a Supplement Analysis (SA) to support a DOE determination with respect to the criteria of 40 CFR 1502.9c. The same regulation further states that the SA will contain sufficient information for DOE to determine (1) whether an existing EIS should be supplemented; (2) a new EIS should be prepared; or (3) no further NEPA documentation is required.

The purpose of this SA is to provide a basis for determining whether the existing PEIS NEPA analysis and documentation would be sufficient to allow the DOE to transport up to 1,700 full cylinders containing DUF_6 from its ETTP location to the Portsmouth site in Fiscal Years (FYs) 2003 through 2005. About 7,000 UF_6 cylinders are stored at the ETTP site, and about 4,700 of these are full, 48-in.-diameter cylinders that contain DUF_6. The remaining 2,300 cylinders include empty cylinders, heel cylinders, and partially full cylinders. These various cylinders include many different designs and may contain UF_6 of various enrichment levels. Approximately 1,100 Non-DUF6 cylinders [i.e., cylinders containing low-enriched uranium (LEU) or normal UF6 (i.e., containing uranium-235 at a concentration equal to that found in

[1] 1 tonne (t) (or metric ton) = 1,000 kilograms, or approximately 2,205 pounds.

nature)] are planned for eventual transportation to the Portsmouth site; potential environmental impacts from transportation of these Non-DUF6 cylinders will be addressed in the site-specific DUF6 conversion EISs for Paducah and Portsmouth, which are currently being prepared. This SA addresses only 1,700 full cylinders at ETTP that contain DUF_6, that can be shown to meet the transportation requirements of the U.S. Department of Transportation (DOT) (as specified in ANSI N14.1, "Uranium Hexafluoride - Packaging for Transport"), and that could be shipped in FYs 2003 through 2005.

The Record of Decision (ROD) for the DUF_6 PEIS, which was issued in August 1999 (*Federal Register*, Volume 64, page 43358 [64 FR 43358]), stated the DOE's decision to promptly convert the DUF_6 inventory to a more stable chemical form (DOE 1999b). The ROD also indicated that "…approximately 4,700 cylinders containing depleted UF_6 that are located at the ETTP (formerly known as the K-25 Site), in Oak Ridge, Tennessee, would be shipped to a conversion facility." The DOE is in the process of preparing two site-specific EISs for the construction and operation of DUF_6 conversion facilities at the Portsmouth and Paducah sites. The conversion facilities would be constructed in fulfillment of the PEIS ROD and a subsequent Federal Law (Public Law 107-206) that specified Portsmouth and Paducah as the locations for the conversion facilities. DOE intends to include in each of the conversion facility EISs an evaluation of the impacts from transporting the *entire* ETTP UF_6 cylinder inventory to both the Portsmouth and Paducah sites. The EIS evaluations will include the full DUF_6 cylinders, as well as heel and partially full cylinders containing UF_6 of various enrichments. Current plans call for the draft conversion facilities EISs to be published for public review in July 2003, with the final EISs being issued in January 2004.

1.2 BACKGROUND

This section provides background information concerning the inventory of DUF_6 stored at the ETTP site, regulatory requirements, and a summary of previous NEPA and other technical analyses performed by the DOE that address the potential environmental impacts associated with transportation of UF_6 cylinders from ETTP to Portsmouth.

1.2.1 ETTP DUF_6 Cylinder Inventory and DOT Shipment Requirements

As noted above, approximately 4,700 full cylinders of DUF_6 are currently stored at the ETTP site. These cylinders contain approximately 56,000 t of DUF_6. Several cylinder types are in use, although the vast majority have a 14-ton (12-t) capacity. These specific cylinders are 12 ft (3.7 m) long by 4 ft (1.2 m) in diameter; most have a steel wall that is 5/16 in. (0.79 cm) thick. Similar, but slightly smaller, 48-in. diameter cylinders with a capacity of 10 tons (9 t) are also in use.

All shipments of ETTP cylinders would have to be made in accordance with applicable DOT regulations for the shipment of radioactive materials, specifically, the provisions of 49 CFR Part 173, Subpart I. The cylinders could be shipped by truck or rail; however, the DOE proposes to ship up to 1,700 cylinders in FYs 2003 through 2005 by truck only.

The DOT regulations in 49 CFR 173.420(a)(2) require that each UF_6 cylinder be designed, fabricated, inspected, tested, and marked in accordance with the various engineering standards that were in effect at the time the cylinder was manufactured. The DOT requirements are intended to maintain the safety of shipments during both routine and accident conditions. Three provisions in 49 CFR 173.420 and ANSI N14.1 are particularly important relative to DUF_6 cylinder shipments:

1. A cylinder must be filled to less than 62% of the certified volumetric capacity (the fill-limit was reduced to 62% from 64% in about 1987);

2. The pressure within a cylinder must be less than 14.8 psia per DOT (sub atmospheric per ANSI); and,

3. A cylinder must be free of cracks, excessive distortion, bent or broken valves or plugs, and broken or torn stiffening rings or skirts, and must not have shell thicknesses that have decreased below a specified minimum value. (Shell thicknesses are assessed visually by a code vessel inspector and ultrasonic testing may be specified at the discretion of the inspector to verify wall thickness, when and in areas they deem necessary.)

Cylinders not meeting these requirements are referred to as overfilled, overpressurized, or damaged, respectively, and cannot be shipped as ANSI N14.1 or DOT compliant cylinders unless the nonconforming condition is corrected, or an exemption is obtained from DOT for shipment.

As noted above, this SA addresses the shipment of up to 1,700 full DUF_6 cylinders that can be shown to be DOT compliant. Before shipment, each cylinder would be inspected to confirm that it meets the DOT requirements. This inspection would include a record review to determine if the cylinder was overfilled; a visual inspection for damage or defects; a pressure check to determine if the cylinder was overpressurized; and determination, based on visual inspection, of compliance with minimum wall thickness requirements, as confirmed by ultrasonic testing, if required by the inspector. If a cylinder passed the inspection, the appropriate documentation would be prepared, and the cylinder would be loaded on a conveyance vehicle for shipment.

1.2.2 Programmatic Environmental Impact Statement

As part of the PEIS, the DOE analyzed the potential environmental impacts of transporting 4,683 full DUF_6 cylinders from ETTP to an unspecified location within the continental United States at three different distances: 250 km (155 mi), 1,000 km (620 mi), and 5,000 km (3,100 mi). Transportation by both truck and rail was considered. The assessment considered risks during both routine (incident-free) transportation conditions as well as from accidents. Because destination sites for the cylinders were not known at the time, the impacts were estimated on the basis of representative national average route statistics. National average

accident occurrence rates (accidents per million miles) and fatality rates (accident fatalities per million miles) were used for accident calculations for truck and rail shipments. Transportation of both DOT compliant and noncompliant cylinders was analyzed. The noncompliant cylinders were assumed to be transported in overpacks or have their contents transferred into compliant cylinders at ETTP before being transported off-site.

The potential receptors of exposure resulting from DUF_6 transport considered in the analyses included workers who load and unload the cylinders, transportation crews, and members of the general public who live along the transportation routes, as well as members of the public who share the roads or rest stops with the DUF_6 cylinder transport vehicles. The assessment also considered impacts to maximally exposed individuals for several very specific exposure scenarios, such as vehicle inspectors, persons in vehicles stopped next to a shipment, and a resident living along a site entrance or exit road. Both radiological and nonradiological, including chemical and vehicle related, impacts were estimated.

Similar to the assessment of cylinders at ETTP, the DOE also analyzed the potential impacts from transporting the approximately 53,000 DUF_6 cylinders under its management responsibility at its Portsmouth and Paducah sites to an unspecified location in the continental United States over similar distances. The impacts estimated for these postulated cylinder transportation campaigns were presented in Appendix J and Sections 5.2.2, and 6.3.2.2 of the PEIS. The PEIS assessment methods and impacts are summarized in Section 2.1 below.

1.2.3 Technical Analyses Performed after the PEIS

As noted above, the PEIS ROD did not identify the site(s) at which the DUF_6 conversion would take place. However, because of Public Law 105-204, which was passed by the Congress and signed by the President in July 1998, it was apparent that the conversion facilities were likely to be built at Portsmouth and/or Paducah. Therefore, in 1999, DOE contracted with Argonne National Laboratory (Argonne), the organization that helped the DOE prepare the DUF_6 PEIS, to analyze the impacts specifically associated with the transportation of DUF_6 cylinders from ETTP to Portsmouth and Paducah and to document the results in a published technical report. The report *Transportation Impact Assessment for Shipment of Uranium Hexafluoride (UF_6) Cylinders from the East Tennessee Technology Park to the Portsmouth and Paducah Gaseous Diffusion Plants (ANL/EAD/TM-112)*, hereafter referred to as the Argonne report, was published in October 2001 (Biwer et al. 2001). The report describes the methods used to estimate the environmental impacts of transporting the ETTP cylinders to Portsmouth and Paducah and presents the estimated environmental impacts.

The Argonne analyses were conducted at a level of detail typical of site-specific NEPA reviews. The options and analyses that were considered in a generic sense in the DUF_6 PEIS were repeated using site-specific routes between the ETTP and Portsmouth sites and between the ETTP and Paducah sites. In addition to the 4,683 full DUF_6 cylinders that were analyzed in the PEIS, the Argonne analysis also included the transportation of approximately 2,400 cylinders of various sizes that were less than full with DUF_6, empty, or contained normal assay or enriched

(generally less than 5%) UF_6. Section 2.2 summarizes the results from the site-specific analyses contained in the Argonne report (Biwer et al. 2001).

1.3 PROPOSED PLAN FOR TRANSPORTATION OF DOT COMPLIANT DUF_6 CYLINDERS FROM ETTP TO PORTSMOUTH IN FYs 2003 THROUGH 2005

The DOE proposes to move up to 1,700 full DUF_6 cylinders from ETTP to Portsmouth in FYs 2003 through 2005. All of these cylinders will be compliant with all regulatory requirements. The DOE and its contractor, Bechtel Jacobs Company, will perform measurements, inspections, and analyses necessary to verify that the cylinders will meet all the requirements for shipping to Portsmouth. An appropriate combination of process knowledge and measurements will be employed to ensure that shipments are both ANSI N14.1 and DOT compliant.

Shipments of full DUF_6 cylinders to Portsmouth are planned to begin in FY 2003, at a rate of four to ten 48-in.-diameter cylinders per day. All shipments will be made by legal-weight truck. The cylinders will be loaded onto a for-hire carrier's 48-ft, steel, flat-bed or low-boy type trailer inside the ETTP site boundaries using typical cylinder handling equipment. Before releasing a shipment, a preshipment inspection of the truck tractor, trailer, driver qualifications, tiedowns, marking and labeling, placards, and shipping documents will be verified for compliance with all appropriate regulations.

2 SUMMARY OF PREVIOUS ANALYSES

2.1 DUF_6 PEIS

As discussed in Section 1, the PEIS included an evaluation of the potential environmental impacts of transporting 4,683 full DUF_6 cylinders from ETTP to an unspecified location within the continental United States over three different distances: 250 km (155 mi), 1,000 km (620 mi), and 5,000 km (3,100 mi). Transportation by both truck and rail was considered. Truck shipments were assumed to consist of one 48-in. diameter cylinder per truck, with rail shipments consisting of four 48-in.-diameter cylinders per railcar. The assessment considered risks during both routine (incident-free) transportation conditions as well as from accidents. The following sections provide a brief overview of the PEIS technical approach and a summary of the assessment results.

2.1.1 PEIS Technical Approach

In the PEIS, the impacts of transportation were calculated in three areas: (1) collective population risks during routine conditions and accidents, (2) radiological risks to maximally exposed individuals (MEIs) during routine conditions, and (3) consequences to individuals and populations after the most severe accidents involving a release of material. Figure 1 provides a summary of the technical approach used in the evaluation; details are provided in Appendix J of the PEIS (DOE 1999a). Because actual destinations were unknown when the PEIS was being prepared, the assessment was based on national average route data and accident statistics. In addition, the potential impacts at ETTP from the preparation of cylinders for shipment were considered.

Collective Population Risk. The collective population risk is a measure of the total risk posed to society as a whole by the actions being considered. For a collective population risk assessment, the persons exposed are considered as a group, without specifying individual receptors. Collective risks were estimated for two groups of receptors: members of the general public and workers. The collective population risk is used as the primary means of evaluating the overall risk from transportation activities.

Collective population risks are presented in the PEIS for both cargo- and vehicle-related causes for routine transportation and accidents. For shipments of DUF_6 cylinders, the cargo-related risks are associated with exposure to low levels of radiation in the vicinity of a shipment and from the potential release of radioactive material in the event of a severe accident. Vehicle-related risks are independent of the cargo in the shipment and include risks from vehicular exhaust emissions and traffic accidents (fatalities caused by physical trauma). The collective accident risk takes into account consequences and probability of a range of potential accidents, from high-probability/low-consequence events to low-probability/high-consequence events.

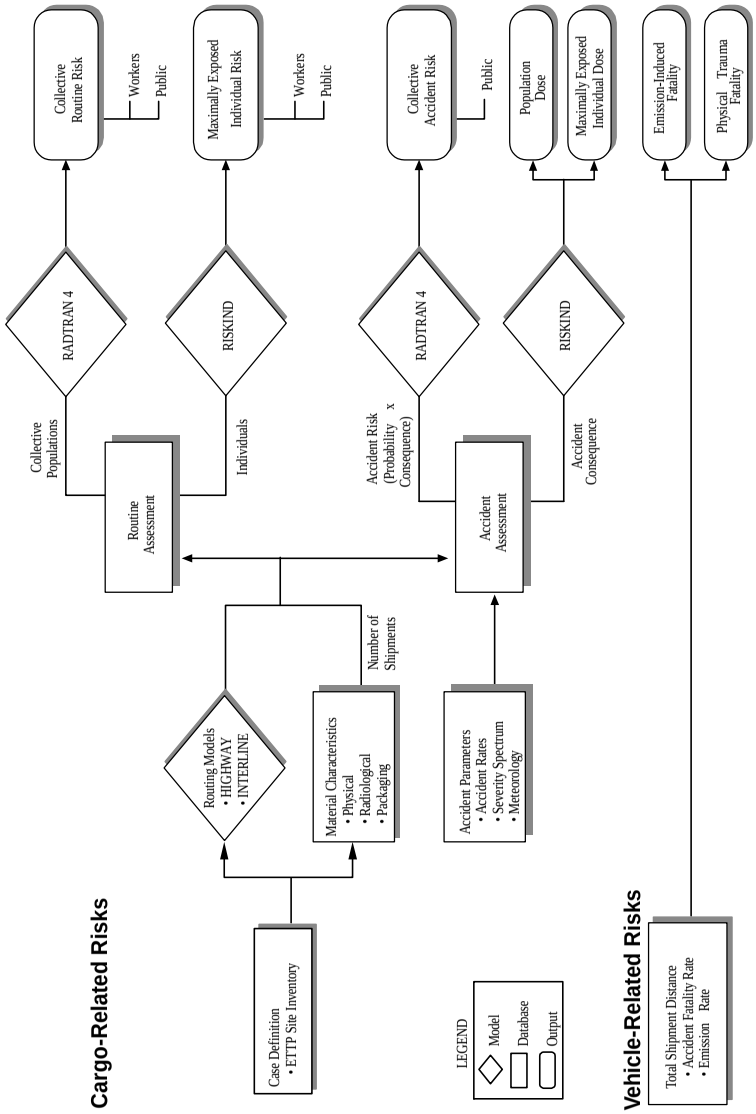

FIGURE 1 Technical Approach Used in the DUF_6 PEIS to Evaluate Transportation Impacts from DUF_6 Cylinder Shipments

Maximally Exposed Individuals (MEIs) during Routine Conditions. During routine transportation, specific individuals may be exposed to radiation in the vicinity of a shipment. The PEIS estimated the risk to those individuals for a number of hypothetical exposure-causing events. The receptors include transportation crew members, inspectors, and members of the public exposed during traffic delays, while working at a service station, or while living near an origin or destination site. The scenarios for exposure were not meant to be exhaustive; they were selected to provide a range of representative potential exposures.

Accident Consequence Assessment. Whereas the collective accident risk assessment considers the entire range of accident severities and their related probabilities, the accident consequence assessment assumes that an accident of the highest severity category has occurred. The consequences, in terms of committed dose (rem) and potential latent cancer fatalities from radiological exposures and number of persons with potential for adverse effects, irreversible adverse health effects, and fatalities due to chemical exposures, were estimated for these extremely severe accidents occurring in rural, suburban, and urban locations under two different sets of weather conditions.

Cylinder Preparation. The site-specific impacts of preparing both compliant and noncompliant cylinders at ETTP for shipment were evaluated in Appendix E of the PEIS. In that evaluation, it was assumed for ETTP that the total number of cylinders not meeting DOT requirements ranged from 2,342 to 4,683 (50% to 100% of the ETTP DUF_6 inventory); correspondingly, from 0 to 2,342 compliant cylinders would require preparation for shipment.

2.1.2 PEIS Results

Collective Population Risk. The results of the total collective population risk assessment conducted for the PEIS are summarized in Table 1. The results are shown for the shipment of 4,683 DUF_6 cylinders from ETTP by truck over representative routes of 1,000 km and 5,000 km. Annual impacts would depend on the duration of the shipping campaign and can be computed by dividing the total risk by the campaign duration. The PEIS results indicate that less than 1 fatality from all causes would be expected even if all 4,683 cylinders were shipped a distance of 5,000 km. The estimated radiation doses from the shipments were much less than levels expected to cause an appreciable increase in the risk of cancer in crew members and the public. The highest fatality risks are from vehicle-related causes, specifically, the risk of fatalities from typical traffic accidents, unrelated to the nature of the cargo. The risks associated with accidents involving the potential release of radioactive material (calculated as the product of the probabilities and consequences of a range of accident severities) were found to be considerably less than both the radiation risks during routine conditions and from vehicle-related accidents.

Maximally Exposed Individuals during Routine Conditions. The PEIS results for MEI exposures during routine conditions are provided in Table 2. The highest potential routine radiological exposure to an MEI, with a LCF risk of 1×10^{-7} per event, would be for a person stopped in traffic for 30 minutes at a distance of 3.3 ft (1 m) from the cargo. It would be unlikely for such an event to occur repeatedly for the same individual. The PEIS points out that there is

TABLE 1 Summary of PEIS Collective Population Risks for DUF_6 Cylinder Shipments From ETTP by Truck

Parameter	DUF_6 PEIS 1,000-km Impacts	DUF_6 PEIS 5,000-km Impacts
Shipment Summary		
Number of shipments	4,683	4,683
Total distance traveled (mi)	2,911,000	14,550,000
Total distance traveled (km)	4,683,000	23,420,000
Cargo-Related Impacts[a]		
Radiological		
Dose risk (person-rem)		
Routine crew[b]	37	190
Routine public	15	75
Accident[c]	0.11	0.54
Latent cancer fatalities[d]		
Crew fatalities[b]	0.01	0.07
Public fatalities	0.008	0.04
Chemical		
Adverse Effects	5×10^{-6}	2×10^{-5}
Irreversible Adverse[e]	3×10^{-6}	2×10^{-5}
Vehicle-Related Impacts[f]		
Emission fatalities	0.02	0.1
Accident fatalities	0.18	0.92

[a] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[b] These results reflect corrections made to the truck crew doses and latent cancer fatality risks in DOE (1999a) and Biwer et al. (1997).

[c] Accident dose risk is a societal risk and is the product of accident probability and accident consequence.

[d] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

[e] Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in the fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

[f] Vehicle-related impacts are impacts independent of the cargo in the shipment.

Sources: PEIS (DOE 1999a) and PEIS supporting information (Biwer et al. 1997).

TABLE 2 Estimated Radiological Impacts to the MEI from Routine Shipment of DUF_6 Cylinders, as Presented in the PEIS

Consequence/Mode	Inspector	Resident	Person in Traffic	Person at Gas Station	Person near Rail Stop
Routine Radiological Dose from a Single Shipment (rem)					
Truck	6.3×10^{-5}	5.4×10^{-9}	2.3×10^{-4}	7.5×10^{-6}	NA[a]
Rail	1.1×10^{-4}	1.5×10^{-8}	2.6×10^{-4}	NA[a]	9.3×10^{-7}
Routine Radiological Risk from a Single Shipment (Lifetime Risk of a LCF)[b]					
Truck	3×10^{-8}	3×10^{-12}	1×10^{-7}	4×10^{-9}	NA[a]
Rail	6×10^{-8}	8×10^{-12}	1×10^{-7}	NA[a]	5×10^{-10}

[a] NA = not applicable.

[b] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers, and 5×10^{-7} for the public (ICRP 1991).

Source: PEIS (DOE 1999a), Appendix J, Table J.7.

the possibility for multiple exposures for some scenarios. For example, if an individual lived near the ETTP site, that resident could receive a combined dose of less than 3×10^{-5} rem if present for all 4,683 shipments considered (calculated as the product of 4,683 shipments and an estimated exposure per shipment of 5.4×10^{-9} rem). This dose is more than 10,000 times lower than the individual average annual exposure of 0.3 rem from natural background radiation.

Accident Consequence. The results of the PEIS accident consequence assessment are summarized in Table 3. As discussed in the PEIS, the highest-consequence hypothetical accident involving DUF_6 cylinders was found to be an extremely severe accident occurring in a densely populated urban area under stable weather conditions. In such an accident, the cylinder (or cylinders for rail accidents) could be breached, releasing uranium and hydrogen fluoride (HF) produced from the chemical reaction of UF_6 with moisture in the air. For these accidents, it was estimated that about 3 million people could be exposed to small amounts of uranium as it was dispersed by the wind, assuming a population density of 1,600 persons/km^2. However, it is important to note that the urban population density generally applies to relatively small urbanized area — very few, if any, urban areas have a population density as high as 1,600 persons/km^2 extending as far as 50 mi (80 km). The urban population density corresponds to approximately 32 million people within the 50-mi (80-km) radius.

In the PEIS, it was estimated that up to 60 LCFs from radiation exposure might occur following a severe urban rail accident involving the breach of four DUF_6 cylinders under stable weather conditions (such as at nighttime). For truck accidents, the PEIS estimated that up to 20 LCFs might result from a similar accident involving one cylinder. In addition, it was estimated that approximately four persons for a rail accident and three persons for a truck

TABLE 3 Potential Consequences to the Population from Severe DUF_6 Transportation Accidents, as Presented in the DUF_6 PEIS[a]

	Neutral Weather Conditions			Stable Weather Conditions		
Consequence/Mode	Rural	Suburban	Urban[b]	Rural	Suburban	Urban[b]
Radiological Dose (person-rem)						
Truck	590	580	1,300	15,000	15,000	32,000
Rail	2,400	2,300	5,200	60,000	58,000	130,000
Radiological Risk (LCF)[c]						
Truck	0.3	0.3	0.6	7	7	20
Rail	1	1	3	30	30	60
Chemical Effects (Number of Persons with Potential for Irreversible Adverse Health Effects)[d]						
Truck	0	1	2	0	1	3
Rail	0	1	3	0	2	4

[a] National average population densities were used for the accident consequence assessment, corresponding to densities of 6 persons/km^2, 719 persons/km^2, and 1,600 persons/km^2 for rural, suburban, and urban zones, respectively. Potential impacts were estimated for the population within a 50-mi (80-km) radius, assuming a uniform population density for each zone.

[b] It is important to note that the urban population density generally applies to relatively small urbanized area — very few, if any, urban areas have a population density as high as the 1,600 persons/km^2 extending as far as 50 mi (80 km). The urban population density corresponds to approximately 32 million people within the 50-mi (80-km) radius, well in excess of the total populations along the routes considered in this assessment.

[c] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for worker and 5×10^{-4} for the public (ICRP 1991).

[d] Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in the fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

Source: PEIS (DOE 1999a), Appendix J, Table J.13.

accident might experience irreversible adverse effects (such as lung or kidney damage) from exposure to HF and uranium. The number of fatalities expected following an HF or uranium chemical exposure was projected to be somewhat less than 1% of the potential irreversible adverse effects. Thus, no fatalities would be expected (1% of 3 or 4 irreversible adverse effects predicted in an urban environment for truck and rail shipment, respectively [Table 3]) from chemical causes. For comparison, in a population of 3 million people, approximately 700,000 would be expected to die of cancer from all causes.

It is pointed out in the PEIS that the occurrence of a severe accident breaching cylinders in a densely populated urban area under stable weather conditions would be expected to be rare. The consequences of cylinder accidents occurring in rural and suburban environments and during unstable weather conditions (typical of daytime) were also assessed in the PEIS. The consequences of those other accident conditions were estimated to be considerably less than those described above for the severe urban accidents.

Cylinder Preparation. Before shipment, cylinders would require some preparation and handling at ETTP. In the PEIS, it was estimated that the total collective dose to involved workers at ETTP would range up to 27 person-rem (resulting in less than 0.01 LCF) for preparation of 2,342 compliant cylinders. This dose to workers would be incurred over the duration of the cylinder preparation operations (annual doses can be estimated by dividing the total dose by the duration of the operation in years).

2.2 RESULTS OF TECHNICAL ANALYSIS PERFORMED AFTER THE PEIS

The report *Transportation Impact Assessment for Shipment of Uranium Hexafluoride (UF_6) Cylinders from the East Tennessee Technology Park to the Portsmouth and Paducah Gaseous Diffusion Plants* (ANL/EAD/TM-112), was published by Argonne in October 2001 (Biwer et al. 2001). In addition to the 4,683 full DUF_6 cylinders that were analyzed in the PEIS, the Argonne analysis also included the transportation of approximately 2,400 cylinders of various sizes that were less than full with DUF_6, empty, or contained normal assay or enriched (generally less than 5%) UF_6. The Argonne report did not evaluate impacts associated with cylinder preparation activities at the ETTP site. The technical approach and results are summarized below.

2.2.1 Argonne Report Technical Approach

The Argonne analyses were conducted in a manner similar to the PEIS assessment described above (Figure 1). However, route-prediction models were used to identify representative routes between ETTP and the Portsmouth site and between ETTP and the Paducah site for both truck and rail. The routes were selected to be reasonable and consistent with routing regulations and general practice, but were considered representative because the actual routes that would be used were unknown. However, the predicted routes were benchmarked for reasonableness by comparison with historical routes between the sites used by carriers of

radioactive material. For shipments from ETTP to Portsmouth, the truck route analyzed was 373 mi (600 km) long and the rail route was 427 mi (687 km) long.

In addition, as noted above, the Argonne report evaluated the risks associated with the shipment of several thousand non-DU cylinders. However, the methods and results for the evaluation of these shipments are not relevant to the scope of this SA (which addresses only full DUF_6 cylinders) and are, therefore, not discussed further. Shipment of non-DU cylinders are included in the site-specific conversion EISs.

2.2.2 Argonne Report Results

Collective Population Risk. The results of the total collective population risk assessment presented in the Argonne report are summarized in Table 4. The results are shown for the shipment of 4,683 DUF_6 cylinders from ETTP to Portsmouth by truck over an actual route of 373 mi (600 km). Annual impacts would depend on the duration of the shipping campaign and can be computed by dividing the total risk by the campaign duration. The results indicate that less than 1 fatality from all causes would be expected for shipment of 4,683 cylinders to Portsmouth by truck. The estimated radiation doses from the shipments were much less than levels expected to cause an appreciable increase in the risk of cancer in crew members and the public. The highest fatality risks are from vehicle-related causes, specifically, the risk of fatalities from typical traffic accidents and vehicle emissions, unrelated to the nature of the cargo. The risks associated with accidents involving the potential release of radioactive material (calculated as the product of the probabilities and consequences of a range of accident severities) were found to be considerably less

TABLE 4 Summary of Argonne Report Collective Population Risks for DUF_6 Cylinder Shipments from ETTP to Portsmouth by Truck

Factor	Value
Shipment Summary	
Number of shipments	4,683
Total distance traveled (mi)	1,746,759
Total distance traveled (km)	2,810,535
Cargo-Related Impacts[a]	
Radiological	
Dose risk (person-rem)	
Routine crew	25
Routine public	8.5
Accident[b]	0.23
Latent cancer fatalities[c]	
Crew fatalities	0.01
Public fatalities	0.004
Chemical	
Adverse Effects	4×10^{-6}
Irreversible Adverse[d]	3×10^{-6}
Vehicle-Related Impacts[e]	
Emission fatalities	0.2
Accident fatalities	0.066

a Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

b Accident dose risk is a societal risk and is the product of accident probability and accident consequence.

c Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

d Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

e Vehicle-related impacts are impacts independent of the cargo in the shipment.

Source: Biwer et al. (2001).

than both the radiation risks during routine conditions and from vehicle-related causes.

It should be noted that the Argonne report used an updated methodology for estimating health impacts from vehicle emissions (e.g., engine exhaust and fugitive dust) during routine conditions. This methodology predicts considerably higher health impacts than previous models, such as that used in the PEIS. The new methodology is believed to result in very conservative estimates of the health effects from vehicle emissions.

Maximally Exposed Individuals During Routine Conditions. The results for MEI exposures during routine conditions in the Argonne report are the same as provided in Table 2 above for the PEIS assessment. The results are the same because the same exposure assumptions were used in both reports and the exposure scenarios analyzed are independent of the actual routes used.

Accident Consequence. The accident consequence results presented in the Argonne report are also the same as those reported in the PEIS and in Table 3 above. Because it is impossible to predict the actual location of an accident, the Argonne report presented the consequences of severe accidents for typical population densities in rural, suburban, and urban areas. These results were considered to be representative for the ETTP to Portsmouth shipments.

3 ESTIMATED IMPACTS ASSOCIATED WITH THE PROPOSED TRANSPORTATION PLAN IN FYs 2003 THROUGH 2005

As described in Section 1.3, the DOE proposes to transport up to 1,700 full DUF_6 cylinders from ETTP to Portsmouth in FYs 2003 through 2005. All of these cylinders would be compliant with all regulatory requirements. Shipments of full cylinders to Portsmouth are planned to begin in FY 2003, at a rate of four to ten 48-in.-diameter cylinders per day. All shipments will be made by legal-weight truck on a for-hire carrier's 48 ft., steel, flat-bed or low-boy type trailers. Before a shipment was released, a preshipment inspection of the truck tractor, trailer, driver qualifications, tiedowns, marking and labeling, placards, and shipping documents would be conducted to verify compliance with all appropriate regulations.

The proposed shipment of cylinders from ETTP to Portsmouth by truck is very similar to the action evaluated in the Argonne report (Biwer et al. 2001), differing only in the total number of cylinders under consideration (1,700 cylinders versus 4,683). Therefore, the results presented in the Argonne report were used to estimate the potential environmental impacts associated with the proposed shipments. The estimated impacts are discussed below.

3.1 COLLECTIVE POPULATION RISK

The collective population risks for the proposed shipments were estimated by scaling the results presented in the Argonne report by the number of shipments. The results are presented in Table 5 for the shipment of 1,700 DUF_6 cylinders from ETTP to Portsmouth by truck over an actual route of 373 mi (600 km).

Annual impacts can be computed by dividing the total risk by the campaign duration, assumed to be 2 to 3 years. The results indicate that much less than 1 fatality from all causes would be expected for the shipment campaign. The estimated radiation doses from the shipments are much less than levels expected to cause an appreciable increase in the risk of cancer in crew members and the public. The highest fatality risks are from vehicle-related causes, specifically, the risk of fatalities from typical traffic accidents and vehicle emissions, unrelated to the nature of the cargo. The risks associated with accidents involving the potential release of radioactive material (calculated as the product of the probabilities and consequences of a range of accident severities) were found to be considerably less than both the radiation risks during routine conditions and from vehicle-related causes.

3.2 MAXIMALLY EXPOSED INDIVIDUALS DURING ROUTINE CONDITIONS

The potential radiation exposure of MEIs for the proposed shipments would be the same as presented previously in Table 2. The highest potential routine radiological exposure to an MEI on a per-event basis, with a LCF risk of 1×10^{-7} per event, would be for a person stopped in traffic at a distance of 3.3 ft (1 m) from a shipment for 30 minutes. It would be unlikely for such an event to occur repeatedly for the same individual.

The possibility exists for multiple exposures for some scenarios. For example, if an individual lived near the ETTP site, that resident could receive a total dose of about 1×10^{-5} rem if present for the passage of all 1,700 shipments (calculated as the product of 1,700 shipments and an estimated exposure per shipment of 5.4×10^{-9} rem). This dose is more than 30,000 times lower than the individual average annual exposure of 0.3 rem from natural background radiation. In addition, it is estimated that truck inspectors could receive a dose of approximately 0.06 mrem per inspection. If the same inspector were to inspect all 1,700 shipments, the total dose is estimated to be approximately 100 mrem, much less than the annual regulatory limit specified for radiation workers. Overall, the potential exposures of individual members of the public would be expected to be much less than regulatory limits and significantly below levels expected to cause an appreciable risk of radiation-induced health effects.

3.3 ACCIDENT CONSEQUENCE ASSESSMENT

The estimated consequences of severe accidents for the proposed shipments would be the same as presented in Table 3 above for truck shipments. For truck accidents, the PEIS estimated that up to 20 LCFs might result from a severe accident in an urban location under stable (i.e., nighttime) weather conditions. In addition, it was estimated that approximately three persons might experience irreversible adverse effects (such as lung or kidney damage) from exposure to HF and uranium. The number of fatalities expected following an HF or uranium chemical exposure is expected to be somewhat less than 1% of the potential irreversible adverse effects. Thus, no fatalities would be expected (1% of 3 persons) from chemical causes. For comparison, in a population of 3 million people, approximately 700,000 would be expected to die of cancer from

TABLE 5 Estimated Collective Population Risks for Proposed DUF_6 Cylinder Shipments from ETTP to Portsmouth by Truck

Factor	Value
Shipment Summary	
Number of shipments	1,700
Total distance traveled (mi)	634,100
Total distance traveled (km)	1,020,000
Cargo-Related Impacts[a]	
Radiological	
Dose risk (person-rem)	
Routine crew	9.2
Routine public	3.1
Accident[b]	0.083
Latent cancer fatalities[c]	
Crew fatalities	0.004
Public fatalities	0.002
Chemical	
Adverse Effects	1×10^{-6}
Irreversible Adverse[d]	9×10^{-7}
Vehicle-Related Impacts[e]	
Emission fatalities	0.08
Accident fatalities	0.024

a Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

b Accident dose risk is a societal risk and is the product of accident probability and accident consequence.

c Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

d Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

e Vehicle-related impacts are impacts independent of the cargo in the shipment.

all causes.

For typical daytime weather conditions, the projected consequences would be less than those estimated for nighttime conditions.

3.4 CYLINDER PREPARATION AT ETTP

The potential impacts associated with cylinder preparation activities at ETTP for the proposed shipments can be estimated from those presented in the PEIS and summarized in Section 2.1 of this SA. In the PEIS, it was estimated that the total collective dose to involved workers at ETTP would range up to 27 person-rem (resulting in less than 0.01 LCF) for preparation of 2,342 compliant cylinders. Thus, preparation of 1,700 compliant cylinders would be expected to result in a total collective dose among workers of about 20 person-rem, resulting in less than 0.01 LCF. This dose would be incurred among all workers over the duration of the cylinder preparation operations, assumed to be 2 to 3 years. It should be noted that the assumptions used in the PEIS for estimating worker exposure were very conservative, intended to bound potential exposures. In practice, cylinder preparation activities, such as inspecting, unstacking, and loading cylinders, would involve fewer workers and be of shorter duration than assumed in the analysis, resulting in significantly lower worker exposures than the estimates presented in the PEIS. In addition, individual radiation exposures would be monitored in order to keep doses as low as reasonably achievable (ALARA) and well below regulatory limits.

4 DISCUSSION

4.1 COMPARISON OF ESTIMATED RISKS WITH THE PEIS

The estimated collective population risks for the proposed shipment of up to 1,700 DUF_6 cylinders from ETTP to Portsmouth by truck are compared with the results from the Argonne report and the DUF_6 PEIS in Table 6. In general, the collective risks for the proposed campaign are less than the projected risks presented in the PEIS for the shipment of ETTP DUF_6 cylinders over 1,000 km and much less than the PEIS results for shipment over 5,000 km. The one exception is the risk estimate for vehicle emissions (i.e., exhaust emissions and fugitive dust), which is somewhat greater for the proposed shipment campaign than the estimates in the PEIS because of the use of a revised method of estimating such risks. However, the total number of estimated fatalities from all causes for the campaign is much less than 1 and well within the bounds of the PEIS analysis.

With respect to potential exposures of individual members of the public, the estimated doses and risks to MEIs for the proposed shipments would be the same as the per-event results presented in the PEIS (Table 2). The probability of being exposed to multiple shipments during the proposed campaign would be less than would be estimated for the PEIS because of the fewer number of shipments considered.

The maximum estimated consequences for severe accidents for the proposed shipments would also be the same as those reported in the PEIS (Table 3). Because the number of shipments and the cumulative shipment distances would be considerably less than those in the PEIS, the probability of such an accident's occurring also would be less. Thus, the overall risk posed by such a severe accident, which is defined as the product of the accident consequence and the estimated probability, for the proposed campaign would be less than for the shipments considered in the PEIS.

Potential impacts at ETTP from the preparation of the cylinders for shipment for the proposed campaign would also be less than those reported in the PEIS. The PEIS considered preparation of up to 2,342 compliant cylinders for shipment, compared with 1,700 cylinders being considered in this SA.

4.2 IMPLEMENTATION ISSUES

It is possible that the proposed shipment campaign could be conducted with convoys of several trucks traveling together. In addition, escort vehicles could accompany the convoys or individual truck shipments over the entire route or part of it. The use of convoys or escorts would not be expected to significantly alter the assessment results discussed above in Sections 3 and 4. In general, the transportation risk assessment is conducted on a per-shipment basis, with the cumulative risks being summed over all shipments. Because of speed restrictions and other precautionary measures taken during a convoy shipment, it would be unlikely that two or more

TABLE 6 Comparison of Collective Risks Estimated for the Proposed Shipments with Argonne and DUF_6 PEIS Results

Parameter	Proposed Shipments (estimated)	Argonne Report (ETTP to Portsmouth)	DUF_6 PEIS 1,000-km Impacts	DUF_6 PEIS 5,000-km Impacts
Shipment Summary				
Number of shipments	1,700	4,683	4,683	4,683
Total distance traveled (mi)	634,100	1,747,000	2,911,000	14,550,000
Total distance traveled (km)	1,020,000	2,811,000	4,683,000	23,420,000
Cargo-Related Impacts[a]				
Radiological				
Dose risk (person-rem)				
Routine crew	9.2	25	37[b]	190[b]
Routine public	3.1	8.5	15	75
Accident[c]	0.083	0.23	0.11	0.54
Latent cancer fatalities[d]				
Crew fatalities	0.004	0.01	0.01[b]	0.07[b]
Public fatalities	0.002	0.004	0.008	0.04
Chemical				
Adverse Effects	1×10^{-6}	4×10^{-6}	5×10^{-6}	2×10^{-5}
Irreversible Adverse[e]	9×10^{-7}	3×10^{-6}	3×10^{-6}	2×10^{-5}
Vehicle-Related Impacts[f]				
Emission fatalities	0.08	0.2	0.02	0.1
Accident fatalities	0.024	0.066	0.18	0.92

[a] Cargo-related impacts are impacts attributable to the radioactive or chemical nature of the material being transported.

[b] These results reflect corrections made to the truck crew doses and latent cancer fatality risks in DOE (1999a) and Biwer et al. (1997).

[c] Accident dose risk is a societal risk and is the product of accident probability and accident consequence.

[d] Latent cancer fatalities are calculated by multiplying dose by the ICRP Publication 60 health risk conversion factors of 4×10^{-4} fatal cancers per person-rem for workers and 5×10^{-4} for the public (ICRP 1991).

[e] Potential for irreversible adverse effects from chemical exposures. Exposure to HF or uranium compounds is estimated to result in fatality of approximately 1% or less of those persons experiencing irreversible adverse effects (Policastro et al. 1997).

[f] Vehicle-related impacts are impacts independent of the cargo in the shipment.

trucks would be involved in a very severe accident during a convoy shipment and that more than one DUF_6 cylinder would be breached. Convoys would increase the probability of more than one cylinder being involved in an accident compared to single shipments to some extent. However, if such an event should happen, the consequences would be less than those estimated for rail accidents in the PEIS, in which four cylinders were assumed to be breached. In addition, the use of escorts could add to the overall number of vehicles involved in a shipment and increase the total vehicle mileage, potentially increasing the probability of vehicular accidents. However, such an increase would be relatively small.

Overall, the use of convoys would not be expected to change the assessment results or conclusions presented in this SA.

5 CONCLUSIONS

The DOE proposal to ship up to 1,700 DOT-compliant full UF_6 cylinders from ETTP to Portsmouth in FYs 2003 through 2005 is not projected to result in potential environmental impacts that are significantly different from those analyzed and presented in the UF_6 PEIS (DOE 1999a). The estimated impacts from the proposed transportation campaign are less than or equal to those described in the PEIS for shipment of the entire ETTP cylinder inventory. Therefore, no supplemental EIS is necessary, and no additional NEPA documentation is required.

6 REFERENCES

Biwer, B.M., et al., 1997, *Transportation Impact Analyses in Support of the Depleted Uranium Hexafluoride Programmatic Environmental Impact Statement*, attachment to intraoffice memorandum from B.M. Biwer to H.I. Avci (Argonne National Laboratory, Argonne, Ill.), May 21.

Biwer, B.M., et al., 2001, *Transportation Impact Assessment for Shipment of Uranium Hexafluoride (UF_6) Cylinders from the East Tennessee Technology Park to the Portsmouth and Paducah Gaseous Diffusion Plants*, ANL/EAD/TM-112, Argonne National Laboratory, Argonne, Ill., Oct.

DOE (U.S. Department of Energy), 1999a, *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride*, DOE/EIS-0269, Office of Nuclear Energy, Science and Technology, Germantown, Md., April.

DOE, 1999b, *Record of Decision for Long-Term Management and Use of Depleted Uranium Hexafluoride*, 6450-01-P, Washington, D.C., Aug. 2.

ICRP (International Commission on Radiological Protection), 1991, *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Pergamon Press, Oxford, United Kingdom.

Policastro, A.J., et al., 1997, *Facility Accident Impact Analyses in Support of the Uranium Hexafluoride Programmatic Environmental Impact Statement*, attachment to intraoffice memorandum from A.J. Policastro to H.I. Avci (Argonne National Laboratory, Argonne, Ill.), June 15.